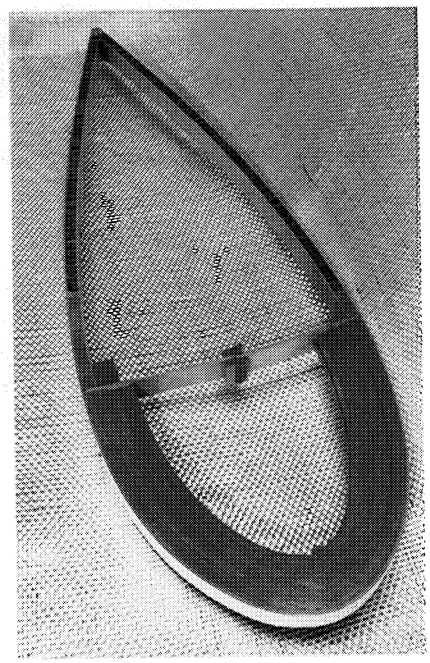
A Two-Way Spinoff

An unusual technology transfer, involving sailboats and commercial wind energy systems, highlights spinoffs for home, consumer and recreational use

This NASA-developed wind turbine generator in Hawaii provides enough electricity for 100 homes. Its wood composite blades were made by Gougeon Brothers Inc., a Michigan sailboat builder which has also become a leading firm in commercial wind turbine manufacture.



This cross-section view of a 60-foot wind turbine blade illustrates the Gougeon technique of laminating multiple layers of wood, bonded by a plastic substance, to produce a light, strong and very stable structure.

Gougeon Brothers Inc, Bay City, Michigan is a small business producer of high-performance sailboats, iceboats and wind turbine rotor blades. That may sound like an oddly mixed product line but, in this instance at least, there is a direct connection between boatbuilding and bladebuilding; the Gougeons—Meade, Jan and Joe—got into the blade fabrication business as a result of their boat construction expertise. It's an unusual spinoff story, because the technology initially transferred did not flow from NASA to the Gougeons—it was the other way around. The Gougeons successfully applied their boatbuilding know-how to a NASA problem in wind turbine development and eventually the spinoff benefits came full-cycle: as a result of their NASA involvement Gougeon Brothers not only acquired a whole new product line but also expanded its engineering competence and improved its boatbuilding techniques.

It started several years ago when NASA and the Department of Energy, looking for energy alternatives to fossil fuels, began experimenting with large wind turbine machines. A wind turbine is simple in principle; a modern counterpart of the age-old windmill, it harnesses the power of the wind to spin a bladed rotor, which in turn drives an electricity-generating turbine. However, the wind turbine loses some of its simplicity as it gets bigger. To generate electricity on a large scale requires supersize rotor blades, and with increasing size comes increasing stress and strain on the spinning blades. That was the problem Lewis Research Center faced in developing a first generation wind turbine generator known as MOD-OA, a 200,000-watt system with a rotor diameter of 125 feet, including two 60-foot blades affixed to the turbine-driving rotor

The large blade in the picture is a 60-footer developed for NASA; the smaller blades are Gougeon products manufactured for commercial wind turbines that provide electricity for homes, farms, apartment complexes and small utilities.

hub. Produced by a leading aerospace firm, the metal blades kept failing under stress. Lewis researchers were exploring every avenue in search of an answer.

The Gougeons, it turned out, had an answer. At Bay City, on Lake Huron's Saginaw Bay, they were turning out high quality boats based on techniques they had developed for fabricating wood composite structures. Their composites were multiple laminated layers of various woods bonded together by epoxy resin adhesive. They used a high percentage of adhesive to get a composite with a ratio of about 75 percent wood to 25 percent plastic, which resulted in a structure lighter yet stronger and far more stable than solid wood.

At a boatbuilding seminar in Cleveland, Ohio, Gougeon Brothers chairman Meade Gougeon described his company's special techniques to an audience that included a very interested Lewis Research Center engineer. This, thought the man from Lewis, could be the answer to the MOD-OA wind turbine's problems—strong and highly stable wooden blades that might stand up better under stress than metal.

To brief a story that took a couple of years to unfold, the Gougeons were interested in trying their hand at building a wind turbine blade, NASA officials visited the Bay city facility to check out their competence, a contract was awarded to study the feasibility of wood blades in wind turbines, and Gougeon Brothers went on to build several sets of blades for the MOD-OA system; all worked successfully. The basic blade was made of multiple laminates, as many as 76 layers in some places, mostly of fir with some spruce and birch; it turned out to be not only better than its metal predecessor, but cheaper. One set of blades is still going strong, after several thousand hours of operation, in a wind turbine in Oahu, Hawaii; NASA fatigue tests indicate the blades could last 30 years.

The NASA assignment involved extensive research by Gougeon Brothers and led to the company's development of new manufacturing processes for producing high-quality wood composite structures at low cost. One result is that the company has become a leading blade producer in the small but growing industry which manufactures wind energy systems. For Enertech, a Norwich, Vermont manufacturer of small wind machines, Gougeon Brothers produces a 10-foot and a 22½-foot blade used in a 4,000-watt generator designed for home use. Gougeon supplies blades of 22½ and 26½ feet to Energy Sciences, Inc., Boulder, Colorado for wind turbines generating power for farms, apartment complexes and small utilities. Gougeon Brothers has also been selected as blade subcontractor in a General Electric Company project involving the largest wind turbine yet designed—a 400-foot diameter system capable of feeding utility companies 6-7 million watts of electricity per hour.

In the course of studying rotor blade aerodynamics, Gougeon Brothers also acquired new know-how applicable to boatbuilding, for example, the company's innovative "aerodynamic mast" for sailboats. Large boat masts are generally supported by rigging and held in a fixed position. The Gougeons have developed a strong, lightweight wood composite mast which needs no supporting rigging and is free to rotate with the wind. The mast becomes, in effect, the leading edge of a mast/sail airfoil which operates like a highly efficient airplane wing. This provides a sailboat a new degree of propulsive efficiency and it could, says Meade Gougeon, make commercial sailing feasible; used as an auxiliary power source, the rotating mast/sail could cut a ship's fuel cost by as much as 40 percent.

Company chairman Meade Gougeon (in red) displays the innovative "aerodynamic mast", an efficiency improvement for sailboats inspired by Gougeon Brothers' work on NASA wind turbines.